Socio-Ethical Implications of Using AI in Accelerating SDG3 in Least Developed Countries

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PII: S2666-6596(20)30006-8
DOI: https://doi.org/10.1016/j.jrt.2020.100006
Reference: JRT 100006

To appear in: *Journal of Responsible Technology*

Received date: 1 July 2020
Revised date: 22 October 2020
Accepted date: 23 October 2020

Please cite this article as: Kutoma Wakunuma , Tilimbe Jiya , Suleiman Aliyu , Socio-Ethical Implications of Using AI in Accelerating SDG3 in Least Developed Countries, *Journal of Responsible Technology* (2020), doi: https://doi.org/10.1016/j.jrt.2020.100006

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Abstract

Artificial Intelligence (AI) is playing a crucial role in advancing efforts towards sustainable development across the globe. AI has the potential to help address some of the biggest challenges that society faces including health and well-being. Thus, AI can be useful in addressing some health and well-being related challenges by accelerating the attainment of the UN's Sustainable Development Goal 3 (SDG3), namely Good health and well-being. This paper draws on the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) list of Official Development Assistance (ODA) and the Price Waterhouse Coopers (PwC) SDG selector to identify the SDG that is prioritised in Least Developed Countries (LDCs). Out of 32 least developed African countries on the list, SDG3 was the most common SDG, suggesting that health and well-being is a priority for these countries. In order to understand the opportunities and challenges that might result in applying AI in the acceleration of SDG3, the paper uses a SWOT analysis to highlight some socio-ethical implications of using AI in advancing SDGS in the identified LDCs on the DAC list.

Keywords: Artificial Intelligence, Sustainable Development Goals, SDG3, OECD DAC List, Least Developed Countries, Ethical Issues, Socio-Ethical, SWOT Analysis

Introduction

Artificial Intelligence (AI) is playing a big role in advancing efforts towards sustainable development across the globe. However, its impact is highly felt in developed economies. For instance, due to AI, automation is playing a key role in many areas. Automation is of course, nothing new; robots have been appearing on assembly lines for decades, but big strides have been made with the dawn of AI. The current wave of automation benefits from the ubiquity of cheap computing power with AI pushing software into new areas such as language and image processing. Going forward, it may be that the greater deployment of computers, coupled with other changes in production methods, such as 3D printing, may invert the competitive advantage that emerging markets have had in the form of low-cost labour. This presents an opportunity for developing countries to address some of the challenges that they are faced with (Agbozo, 2018; Panda & Bhatia, 2018; Tjoa & Tjoa, 2016). For instance, with the help from AI, massive amounts of data can be analysed to map poverty and climate change, automate agricultural practices and irrigation, individualise healthcare and learning, predict consumption patterns, streamline energy-usage and waste-management, and outfox poachers and illegal fishing.

The importance of AI in addressing challenges affecting sustainable development is constantly being reaffirmed by the United Nations (UN). The UN acknowledges that AI is advancing dramatically and transforming our world socially, economically and politically. This is seen through a lot of push towards the exploitation of AI in achieving the 17 UN Sustainable Development Goals (SDGs). However, despite its promise in accelerating the attainment of SDGs, there are also serious socio-ethical issues at stake. There are real concerns about transparency, data ownership, privacy, unfair data manipulation and safety, just to mention a few. This paper, therefore, presents a social and ethical analytical view of AI use in promoting SDGs and focuses on SDG3 – Good Health and Wellbeing which appears to be the most pressing one across the OECD's DAC list of Least Developed Countries (LDCs) in Africa. The paper contributes to the discussion of the social and ethical implications of AI use in addressing societal challenges. Hence the paper answers the following research question: *'What are the social and ethical implications of implementing AI to accelerate the attainment of SDG3 for least developed African countries?'*. The paper recognises that SDGs and, in this case, SDG3 are a global concern. However, because focussing the paper on a global scale would have been too general and inconceivable, the decision was made to focus on least developed African countries because by their very nature, they are the least developed and therefore provide a better focus to explore the question particularly in relation to a very important global goal and an emerging technology in the form of AI. Further, because Africa is a vast continent with countries that are categorised differently and having competing challenges, it made logical sense to choose one specific category from the OECD DAC list. The choice of least developed African countries enabled the paper to be more

focussed and address countries within the same category and with a similar recurring SDG across the board.

The next section describes the relationship between AI and SDG3 in least developed countries within Africa. This is followed by an account of the methodology employed in the paper. The paper then discusses the results of a SWOT analysis through a presentation of a socio-ethical view of the use of AI towards achieving SDG3.

Artificial Intelligence and SDG3 in African Developing Countries

This section aims to give a descriptive review of the role of AI in accelerating the attainment of SDG3 in developing countries within Africa. It starts by giving a brief background of SDGs and then narrows it down to a review of the role of AI in attaining SDG3.

2.1 Sustainable Development Goal 3

SDGs follow on from the UNs Millennium Development Goals (MDGs) which were set in 2000 to help overcome some of the societal challenges by the year 2015. Specifically, 8 MDGs were set which included eradication of extreme poverty and hunger; achievement of universal primary education; promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health; combat HIV/AIDS, malaria and other diseases; environmental sustainability and development of global partnerships for development (Agbozo, 2018; Gusmão Caiado, Leal Filho, Quelhas, Luiz de Mattos Nascimento, & Ávila, 2018; Vinuesa et al., 2019a). 15 years later, although progress had been made in certain areas targeted by the MDGs, more needed to be done with respect to tackling societal challenges and this resulted in the SDGs which were started in 2015 and are expected to be achieved by 2030 (UN, 2019; United Nations, 2015) (A complete list of all the 17 SDGs are listed in Appendix 1: UN Sustainable Development Goals). While the MDGs were specific to developing countries, the SDGs are more global and cover challenges associated in both developed and developing countries, although the fact remains that they are more relatable to developing countries due to the vast amount of challenges that developing countries face.

One of the pressing challenges in developing countries relates to health. Many developing countries in Africa are yet to adopt better and innovative ways of improving the health and well-being of its populace. It is for this reason that this paper focuses on developing countries with particular focus on specific African countries on the subject of AI and the role such a technology might have in achieving SDG3. SDG3 is one of the UN goals which is aimed at ensuring healthy lives and promoting well-being for all at all ages. SGD3 was put in place to continue from MDG 5 whose focus was on the improvement of maternal health (Ogu et al., 2016). For instance, SDG3 was designed to fully address a reduction in maternal mortality rate (SDG3.2) and reduction of exposure to toxic substances to improve health (SDG3.9) (Howden-Chapman et al., n.d.) among some of its targets. With a growing population, Africa can be better positioned to greatly benefit from the implementation of AI in overcoming its health challenges such as maternal and child health, infectious and non-communicable diseases.

To understand and contextualise the implications of using AI in accelerating sustainable development, particularly SDG3, we first explain the terminology and then give an overview of the connection between AI and sustainable development within the context of health and well-being.

2.2 Artificial Intelligence and SDG3

There is no single definition of AI that is universally accepted by practitioners. Some define AI loosely as a computerized system that exhibits behaviour that is commonly thought of as requiring intelligence (Campolo et al., 2017; European Commission, 2017; European Economic and Social Committee, 2017). Others define AI as a system capable of rationally solving complex problems or taking appropriate actions to achieve its goals in whatever real-world circumstances it encounters (Accenture, 2017; Hall, W. and Pesenti, J., 2017; IEEE, 2017). The diversity of AI problems and solutions and the foundation of AI in the human evaluation of the performance and accuracy of algorithms makes it difficult to clearly define a bright-line distinction between what constitutes AI and what does not. For example, many techniques used to analyse large volumes of data that were previously developed by AI researchers are now identified as Big Data analytics. Although the boundaries of AI can be uncertain and have tended to shift over time, what is important is that a core objective of AI applications over the years has been to automate or replicate intelligent behaviour (Campolo et al., 2017; European Economic and Social Committee, 2017).

AI has the potential to help address some of the biggest challenges that society faces including health and well-being. Preventative healthcare programs and diagnostics are significantly improved through AI leading to new scientific breakthroughs (Boman & Kruse, 2017; Panda & Bhatia, 2018; Wahl, Cossy-Gantner, Germann, & Schwalbe, 2018). For instance, there are billions of mobile devices with cameras, microphones and motion sensors that are being used to diagnose heart, eye and blood disorders (ITU, 2017), insights into managing cancer, diabetes and chronic illness as well as remote care (Owoyemi et al., 2020).

The use of AI in dealing with health-related issues in Africa is not a new phenomenon. AI has been used in countries such as Kenya to improve health worker-patient interaction, quality and detection of common eye disorders in Egypt (Owoyemi et al., 2020). Recently, there has been an increase in piloting and implementation of AI in dealing with health and well-being related issues in many African countries such as Rwanda, South Africa and Nigeria. Rwanda has been using robots to fight COVID-19 infection rates of health professionals while treating COVID-19 patients. The robots use AI to perform temperature screening including reading other vital signs. They also deliver video messages to health care practitioners as well as detect people not wearing masks and then instruct them to wear them or if not wearing them properly, instruct them to do it in a correct manner (World Health Organisation Rwanda, 2020). In South Africa, AI has been used to help in planning the

efficient allocation of health resources across the health sector (Moyo et al., 2018) while in Nigeria, it has been used to improve diagnosis of infant asphyxia in poor areas. Also, in Zambia and Tanzania, AI has played a crucial role in diagnosing diabetes and tuberculosis (Bellemo et al., 2019). These examples signify that AI is beginning to play a significant role in accelerating the achievement of SDG3 in developing countries in Africa. To finalize, some conclusions and recommendations are provided on how AI can be used in Least Developed countries in Africa to tackle common pressing issues in promoting sustainable development.

Methodology

In this section, we describe the process employed to obtain the findings described in the study. The goal was to answer the following question: *'What are the social and ethical implications of implementing AI to accelerate the attainment of SDG3 for Least Developed African Countries?'*. The authors employed a methodology that uses the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) recipient list and is focussed on understanding, advancing and contributing to the discourse of AI and least developing countries in Africa.

To begin with, a literature search to support the identified connections between AI and SDG3 was conducted. The following sources of information were considered: published work on real-world applications; reports from accredited organisations such as the International Telecommunication Uninion (ITU) which is the UN's specialised agency for Information Communication Technologies (ICT), and the OECD. In order to avoid speculative opinions that were not steeped in any meaningful peer-view process such as educated conjectures, real-world applications without peer-reviewed research; media, public beliefs or similar other were not considered as acceptable evidence.

To support the review of the literature, the research also involved a consideration of which countries in Africa would be suitable for the paper. In considering the countries to look at, the authors also had to understand which priority SDGs the selected countries were coping with the most. As the interest of the paper was in understanding the implementation of AI on SDGs with respect to Least Developing Countries because these are the countries facing the most societal challenges globally, the authors elected to use the OECD DAC Official Development Assistance (ODA) recipient list. This is because the OECD DAC established in 1961, which has 36 members from across the globe compiles the list to promote policies that aim to improve the economic and social well-being of people around the world. The DAC looks into aid, poverty reduction and development by collecting data to assist with aid and resources to countries that need aid (OECD, 2020). As such, data from the ODA list published in 2020 (OECD, 2020) was used for the elicitation process. To assist the readers in understanding this list and how countries are categorised, the list is reproduced in Annex 1: OECD DAC List of ODA Recipients. The list is revised every three years and covers ODA

Recipients for 2018, 2019 and 2020. As can be noted from the List, there are four categories of recipient countries and include:

1. Category 1: Least developed countries
2. Category 2: Other low-income countries (per capita GNI <= $1 005 in 2016)
3. Category 3: Low middle-income countries and territories (per capita GNI $1 006-$3 955 in 2016)
4. Category 4: Upper middle-income countries and territories (per capita GNI $3 956-$12 235 in 2016).

Rather than look at all the countries in each category, the authors felt that it would be more logical and focussed to pay particular attention to one category. The choice was made to concentrate on Category 1 (Least developed countries) because by their very nature they are likely to have more development challenges than countries in the other categories and would therefore be facing more societal challenges. As SDGs are intended to address societal issues, the countries in Category 1 were, therefore, more appropriate for the paper. Because the interest is on African countries, the authors looked at the 32 African countries in Category 1 in tandem with the Price Waterhouse Coopers (PwC) SDG selector to determine which SDGs were a priority. The PwC SDG selector was elected as the appropriate tool for purposes of determining the priority areas of the countries.

Granted, other SDG selectors could have been used and include for example the UN's SDG Indicators database tool (UN, 2020). However, as the development of this global SDG database is still ongoing, the PwC selector was more appropriate for purposes of this paper, particularly due to its ease and simplicity of use. The PwC selector takes into consideration over 200 data sources to score countries performance against each SDG target of which data then drives the country SDG selection. The PwC selector works by addressing 4 categories: Industry Impact; Industry Opportunity, Territory and Theme. The 'Industry Impact' category looks at SDG impact on aspects such as communication, financial services, manufacturing among others while the 'Industry Opportunity' category focuses on potential opportunities on the aforementioned aspects. The 'Territory' category lists all countries. This is an important category which is used for purposes of this paper because it allows for users of the tool to choose a country of choice to understand which SDGs are a priority for the chosen country. The 'Theme' category addresses aspects related to people, prosperity, planet, peace and partnership (PwC, 2020). As the paper uses the OECD DAC list and particularly focusses on Category 1 with respect to Least Developed Countries, all 32 African countries under this category were entered in the Territory category of the PwC SDG selector in order to determine which SDGs were a priority for each country. The SDG selector reveals 5 specific SDGs for any given country. In this case, Table 1 below shows the respective 5 top priority SDGs for the Least Developed Countries under the OECD DAC List in Category 1. All the countries were entered in the PwC SDG Selector to showcase their 5 top priority SDGs.

Least Developing Countries	Priority SDGs				
1. Angola	1	2	8	11	14
2. Benin	2	3	5	7	14
3. Burkina Faso	2	3	4	5	9
4. Burundi	2	3	9	16	17
5. Central African Republic	1	2	3	5	11
6. Chad	1	3	4	9	11
7. Comoros	2	5	8	9	15
8. Democratic Republic of Congo	3	5	8	9	16
9. Djibouti	5	11	13	14	17
10. Eriteria	6	9	11	14	17
11. Ethiopia	3	4	5	6	17
12. Gambia	3	5	9	14	17
13. Guinea	2	3	5	7	9
14. Guinea-Bissau	1	3	4	9	11
15. Lesotho	1	3	7	9	15
16. Liberia	1	2	7	11	14
17. Madagascar	1	2	3	9	14
18. Malawi	1	2	3	5	9
19. Mali	1	3	4	5	9
20. Mauritania	1	3	6	9	11
21. Mozambique	2	3	7	9	16
22. Niger	3	4	7	9	17
23. Rwanda	2	3	6	9	17
24. Senegal	3	4	6	9	14
25. Sierra Leone	1	3	5	11	13
26. Somalia	4	6	9	14	17
27. South Sudan	1	3	7	11	17
28. Sudan	4	8	11	14	17
29. Tanzania	2	3	6	7	9
30. Togo	3	4	6	7	9
31. Uganda	2	3	7	9	16
32. Zambia	1	2	8	9	11

Table 1: Least Developed Countries and their 5 top priority SDGs

As can be seen in Table 1 above, SDG3 (shaded in grey) was the most common SDG across the 32 Least Developed African countries captured from Category 1 of the OECD DAC list. It appeared in 24 out of the 32 countries. This is followed by SDG 9 which appears in 23 out of 32 countries. We have henceforth highlight SDG 3 which is the most common. It is worth noting that as countries are work towards the SDGs the priority SDGs will keep changing over time until they are achieved.

As part of the paper's core remit is to understand the socio-ethical implications of using AI in advancing SDG3, the paper elected to use a SWOT analysis in order to understand the strengthens, weaknesses, opportunities and threats that AI presents in advancing this technology in healthcare. AI is an emerging technology for many countries in Africa. It is therefore not enough to just look at how it is being applied in health care but rather it becomes pertinent to understand its potential strengthens, weaknesses, opportunities and threats that it presents so that the different stakeholders who will potentially be applying the technology as it becomes mainstream are aware of its advantages and challenges. As such, a SWOT analysis presents the opportunity to analyse and understand these elements. Further, a SWOT analysis is important because it presents the paper with an opportunity to come up with recommendations that could be useful for several stakeholders such as policymakers, health care practitioners, industry and the public in the focus countries as they begin to apply AI in the advancement of SDG3.

Findings and Discussion

4.1 A social and ethical analytical view of AI-based technologies in advancing SDG3

AI is a promising phenomenon in accelerating the attainment of almost all the SDGs. However, in this paper, as highlighted in the previous section, we direct our focus on SDG3; Good Health and Well-being. SDG3 appears to be the most pressing goal in most of the least developed countries in Africa. As discussed earlier in this paper, AI has the potential to help such countries in addressing the pressing challenges including those related to health and well-being. However, despite all the promises of AI in helping least developed countries to improve the health and well-being of their populace as part of SDG3, there are also serious social challenges and ethical issues at stake. In this section, we discuss the potential, limitations and implications of using AI-based technologies in advancing SDG3 by firstly conducting a SWOT analysis and then discussing the socio-ethical implications of their use in accelerating SDG3 in least developing countries.

4.2 SWOT for AI towards achieving SDG3

Using a SWOT analysis, the authors were able to perform a holistic strategic exploration of the application of AI to advance healthy living and well-being in the least developed countries selected on the OECD DAC list. Based on the research question and aim of this paper, documents were instrumental in analysing and summarising the findings into four main groups: strengths, weaknesses, opportunities and threats (SWOT) of using AI in

accelerating SDG3. The rationale behind the use of a SWOT analysis in this paper is that it allows a structured recognition of internal and external factors influencing the capabilities of AI towards the attainment of SDG3. At the same time, a SWOT analysis also provided a frame for understanding the limiting factors for using AI to accelerate the SDG3 in the least developed countries. Although SWOT-type analyses are widely used for strategic planning in business, management and policy research, it can be extrapolated to other areas, such as sustainable development and therefore inform decisions about the effectiveness of implementing efforts towards achieving sustainable development, for instance, use of AI in developing countries.

For that reason, we considered it to be a suitable tool to assess implementations of AI towards reaching SDG3 strategically. For the purposes of this paper, each SWOT category refers to the following:

- **Strengths:** These are internal factors referring to outcomes, AI drivers and reasons for its successful implementation in the least developed countries.
- **Weaknesses**: These are internal factors referring to the limitations and challenges of the use of AI in accelerating SDG3 in the least developed countries.
- **Opportunities:** These are external factors such as areas of potential for AI implementation to accelerate SDG3 in the least developed countries.
- **Threats**: These are external factors such as the potential for AI failure, external barriers and limitations towards successful implementation to accelerate SDG3 in the least developed countries.

4.2.1 Internal factors for AI's successful implementation towards SDG3.

When it comes to the use of AI in developing countries in Africa, a lot has been covered on the value of AI implementation in assessing diseases and preventing them. For instance, Ogu et. al (2016) give an account of how AI-based healthcare applications have been effective in overcoming maternal mortality and preventable maternal death in Africa. Relatedly, AI has shown some promising strides in diagnostics and prevention of diseases in Africa, as expounded by Bellemo et. al (2019) and Owoyemi et. al (2016).

Further, because of AI capability to store, manipulate and provide analytical insights from complex and large amounts of data, it is capable of supporting health care research. For instance, researchers can leverage AI to fight against cancer in just a matter of weeks rather than months. AI-based solutions can make personalised recommendations for people presenting symptoms through interfaces in a matter of a short time. By comparing massive amounts of data, including individual patient health data to the greater population, AI can help in developing prescriptive analytics that could be used to determine what sort of health interventions will work best for particular cases and deliver on the promise of precision treatments. In addition to AI aiding the discovery and development of new treatments for

the most insidious diseases that societies in the least developed countries are facing, the technology can also model, predict and perhaps slow the spread of disease in a pandemic outbreak such as the recent Ebola and COVID 19 outbreaks.

4.2.2 External factors driving the potential for AI to accelerate SDG3.

There are several opportunities for leveraging AI in achieving SDG3 in the least developed countries within Africa. Firstly, there are international initiatives in health care and preventing pandemic outbreaks. These initiatives are supporting the combination of complex elements of human biology with the computational power of AI, with a hope to pave a new path to the future of medicine (Goertzel et al., 2010; Liu & Shi, n.d.; Reger et al., 2000). With the use of the opportunities around, the use of AI is capable of promoting a healthier society in the least developed countries with quicker, lower-cost drug discovery and development that leads to more effective treatment and prevention of pandemic outbreaks.

Economically, least developed countries do have the financial resources to afford a wide implementation of AI-based initiatives geared towards SDG3, therefore by being part of several international initiatives such as the Health Information Systems Program (HISP) which manages the District Health Information Software 2 (DHIS2), an open-source, web-based health management information system (HMIS) platform (Dehnavieh et al., 2019), they can enjoy some of the benefits of AI in their health and well-being agendas. Not only are there numerous initiatives geared to use AI in disease preventions, but there are also institutions primarily put in place to enhance health and well-being. These institutions provide an opportunity to use AI towards their aims such as the centres for disease control and prevention which uses AI to investigate and monitor historical and real-time models of cause and effect relationships that could mitigate the progression of pandemics.

So, there are opportunities for AI to play a major role in building the foundation for a new paradigm of treatment, exploiting the robustness of AI-based biological models and the cutting-edge innovation of emerging AI technologies. Also, merging health-related knowledge, for example, biology and the exploitation of AI can offer a new approach to drug discovery and development that could reduce costs and aid rapid development of health solutions for least developed countries. For instance, AI could establish causative relationships between travel data and population medical reports to help map out and predict the spread of disease. This has been the case in the recent COVID 19 pandemic. At the same time, AI can help government agencies to plan more rapid and efficient responses. With limited resources and time, these agencies need to be primed to deploy the right supplies and personnel to the optimal locations at precisely the right time (Corrigan, 2018).

Further, the advancement of smart healthcare information systems and the growth of the smart technologies industry in the least developed countries is another opportunity for implementing AI in accelerating SDG3 within those counties. For most healthcare industries, healthcare transformation through implementing of AI coupled with big data analytics is still in the very early stages in most least developed countries in Africa, however, there is a sturdy and promising progress towards building infrastructure and systems that will aid the provision of AI use in such countries. Such progress is moving forward and affording new research to formulate appropriate strategies that will enable healthcare platforms in places such as Africa and leverage AI efficiently and effectively (Wang et al., 2018). Smart information systems, which are the combination of AI and Big data, are now the holy grail for knowledge creation. Instead of traditional paper-based knowledge bases for diagnosis and prediction, there is lots of data at the individual level for the effective use of health-care systems, clinical trials, real-time monitoring, and provision of proof in clinical research and decision making through AI (Benchoufi & Ravaud, 2017). This is a great opportunity that least developed countries could take advantage of, particularly due to the scarcity of resources and appropriate infrastructure for providing world-class health and well-being services to their societies.

4.2.3 Internal factors limiting the use of AI towards SDG3

There are internal limitations and challenges for implementing AI in achieving SDG3 in the least developing countries across Africa. The main limiting factor of AI implementation revolves around the questions on its explainability and trustworthiness. While AI-based systems can find patterns buried in enormous amounts of existing health data, they may also deliver solutions based on data that may be incomplete or decisions based on patterns that are not clear. The lack of clarity could partly be due to the number of exploration pathways that AI uses to get to the solutions. The pathways could be too complicated and difficult to explain, therefore raising numerous ethical and philosophical questions. Thus, although AI may be used to solve complex problems in health and medicine, or optimising logistical problems to tackle some of the pressing health problems in the least developed countries, it poses a lot of questions around trust and accountability (AI HLEG, 2019; World Economic Forum, 2018). These questions are amplified in the least developed countries where there is limited expertise to understand and explain how the AI-based decisions are made to the masses. This is further augmented by high levels of illiteracy and socio-economic barriers to AI use in such countries therefore potentially resulting in an access divide.

4.2.4 External factors limiting successful AI implementation to accelerate SDG3.

Despite the opportunities for implementing AI in accelerating SDG3, there threats too. One of the threats relates to legal issues, in other words, AI and the Law. As many countries are actively creating the legal conditions for the development of technologies that use artificial intelligence this may not be a similar situation with the least developed countries who are

playing catch-up with the developed world. The legal problems run even deeper, especially in the case of robots in healthcare. A system that learns from the information it receives from the outside world can act in ways that its creators could not have predicted and predictability is crucial to modern legal approaches (Cohen et al., 2014). Moreover, AI-based systems can operate independently from their creators or operators thus complicating the task of determining responsibility. In most least developed countries, there is a lack of guidelines or regulatory provisions to address the issues of responsibility if AI-based interventions in health have not materialised as expected. This could be linked to other challenges that may affect the effective AI use in these countries such as poor governance and resources.

Relatedly, there are numerous options in terms of regulation, including regulation that is based on existing healthcare norms and standards. For example, technologies that use AI and big data can be regulated as items subject to copyright or as property. Difficulties arise here, however, if such technologies act autonomously, against the will of the data subjects, i.e. patients who may not be in a position to give consent (Salerno et al., 2017). In least developed countries these technologies are used without consent from most of the populace due to issues around poor literacy, lack of awareness of rights and flawed enforcement. Moreover, the lack of stringent laws, regulation and rules may slow down the introduction of AI technologies due to the unexpected risks of liability for their creators and inventors. When it comes to implementing AI in healthcare, there is the issue of legal interpretation of use. As an example, some legal systems make legal entities who own AI systems liable under civil and, in certain cases, criminal law. As such, without ascertaining whether parties can have free will or intent, or whether they can act deliberately or knowingly, they can be recognised as legally responsible for certain actions. In the same way, it is not necessary to ascribe intent or free will to AI-based systems to recognise them as responsible for their decisions. This consideration may not be as grounded in the least developed countries as it would be the case in developed ones.

Additionally, AI is dependent on factors like electricity, internet connections among other types of infrastructure. However, in many least developed countries in Africa, the remote areas and villages are devoid of electricity and mobile connection. Lack of these necessary facilities makes the use of AI in accelerating health and well-being initiatives in such places a challenge.

The above findings and discussion with respect to AI use in accelerating the goal of achieving a better health and well-being for the least developed countries is summarised in Table 2 below:

Strengths	Weaknesses
• Doctors/Physicians get patient-record and analyse risk factors to customers via smart devices using machine intelligence • Artificial intelligence is used to inform patients about the side - effects of different medicines. • Radiosurgery helps to operate on tumours without affecting surrounding tissues. • Interactive capability of AI through the use of robotics for example to treat depression.	• AI technology giving wrong predictions and diagnosis in healthcare • Risk of liability for AI developers and medical personnel users • Difficulty in identifying who takes the blame when an AI technology fails (are medical personnel using the technology to blame or is it the AI developers?). This leads to a legal crisis particularly as this is new territory • An AI divide between those who are economically and socially able to access the technology. • AI still remains inhuman. This is important in healthcare where there is still a need for a "human" contact and empathy. AI is not able to grasp human emotions or communicate emotionally.
Opportunities	**Threats**
• Big Data can be applied for Predictive Analytics in Healthcare. • Deep learning (Convolutional neural networks) can be used for radiologic image analysis. • Long short-term memory networks can help predict likelihood occurrences of events e.g. in-hospital mortality rates in intensive care units. • Blockchain can be used to secure (transparency and privacy) patient data on health platforms.	• Security threats that can have an impact on an individual's medical data • Invasion of individuals privacy • Aspects related to consent when it comes to healthcare • Loss of personal relations between clinicians and patients as these will be surrendered to AI such as robotics • Dependency on AI technology which may be problematic when something goes wrong with the technology • Potential loss of jobs within the health sector when AI is used in place of people

Table 2: A SWOT analysis of the use of AI towards SDG3 attainment

4.3 Holistic Socio-ethical Implications of AI use towards SDG3

Artificial Intelligence (AI) is often referred to as the new electricity; poised to drive sustainable growth and development over the coming decades. However, there are social and ethical implications of unchecked AI deployment (Bentley et al., 2018; Buolamwini & Gebru, 2018; Isaak & Hanna, 2018). Some of these implications include biased algorithms,

increased profiling and privacy to introduce a few. Such implications demonstrate an urgent need for better governance of AI. Thus, this section discusses some of the social and ethical considerations particularly related to the use of AI in ensuring healthy lives and promoting well-being for all at all ages in the least developed countries.

As pointed out earlier in this paper, there is ongoing speculation on the implications of computers becoming more intelligent than humans. Some predict that a sufficiently intelligent AI could be tasked with developing even better, more intelligent systems and that these, in turn, could be used to create systems with yet greater intelligence that could help in managing and perhaps eradication some of the global health-related problems through the discovery of ground-breaking treatments and medical knowledge (Guan, 2019b), and so on. In a dystopian vision, these super-intelligent machines would exceed the ability of humans to understand or control health interventions. Such ability of AI to control over many critical health systems could result in havoc with humans no longer in control of their destiny at best and extinction at worst (van Est & Gerritsen, 2017). Although this may sound like a scenario that has long been the subject of science fiction stories, recent pronouncements from some influential industry leaders have highlighted these fears. As such, despite all the good promises of AI in accelerating SDG3, there is a need to reflect on the social and ethical implications of its use, particularly in the least developed countries. Some of the ethical considerations with the use of AI promoting health in the developing world are discussed below.

4.3.1 Transparency and accuracy of AI processes (The explainability issue)

Explaining the results from large, complex AI models in human terms remains one of the key challenges to acceptance by users and regulatory authorities. Opening the AI "black box" to show how decisions are made, as well as which factors, features, and data sets are decisive and which are not, is important for the social use of AI. This is especially true for users of AI in developing countries such as those used in this paper. For instance, stakeholders such as businesses (industry), Non-governmental organisations (NGOs) and in many cases governmental organisations, including those dealing with health-related issues, require a basic level of transparency and probably want to have clear explanations of the decisions that they make. Explainability is of importance for use cases relating to decision making about treatments and disease prevention, in particular, for cases related to patient identification, since patients must be able to understand decisions that are made in a meaningful way (Wachter et al., 2017a, 2017b). Thus, ethical issues like transparency and safety are also paramount importance while deploying AI.

4.3.2 Ownership

Using AI to accelerate SDG3 will involve a collection of different types of data in developing countries. From such data, there will be many innovative outputs and outcomes that will directly come out of the activity. This then raises a concern on one of the most complex

issues that our society is facing, that is, the question of intellectual property rights. There are substantial economic, social and ethical concerns surrounding these rights. For example, in the case of using AI in accelerating the SDG3 in the least developed countries, there is a big concern revolving around the special attributes of information and how it is transmitted due to under-developed and poorly management infrastructures that are put in place for managing intellectual property rights and public data access. In these countries, huge health-related datasets are collected, manipulated and used in AI, and the concern over intellectual property rights relates to the content of information that is yielded from such datasets. Not only is there are concerns about the content, but also there are some equally pressing property rights issues surrounding the channels through which the information passes (EDPS, 2016; Mason, 1986; SGPAC, 2017).

4.3.3 Privacy of sensitive data

Linked to the issue of ownership is the concern over the privacy of sensitive personal data. Using AI in health-related issues involve the collection of sensitive personal data and the issue of privacy when it comes to AI use is already rife (Guan, 2019a; Salerno et al., 2017; Stahl et al., 2018). For instance, there is a possibility of AI use by profit-making and non-profit organisations alike that carries a risk of health, and similar records becoming accessible through porous AI systems to people without a legitimate need to access them (Guan, 2019b; Stahl et al., 2018). With such risk data, privacy and use of personal information are critical socio-ethical issues that need keeping an eye on and ultimately addressing them if AI is to realise its potential in accelerating SDG3.

The other issue relates to the governance, regulation and deployment of AI-driven technology to cure patients. The laws that regulate healthcare technology should adhere to the principle of privacy. Contrary to most least developed countries in Africa, Europe has led the way in this area with the regulation on data privacy with the General Data Protection Regulation (GDPR). The GDPR introduced more stringent consent requirements for data collection, gives users the right to be forgotten and the right to object, and strengthens supervision of parties that collect, control, and process data, with significant fines for failure to comply (Manyika & Bughin, n.d.) Developing countries should have similar stringent and easily enforceable regulations that deal with instances of breaching the privacy of the individuals with the use of AI and AI-driven technologies for health by making the actors and stakeholders accountable and responsible.

4.3.4 Bias, Manipulation and Misuse of AI's potential

One other socio-ethical concern related to building accountable, fair and fully explainable AI-based systems that can help solve some of the challenges that SDG3 is aimed at in developing countries. Some concerns are directly related to the way algorithms and the public or patient data used to train the AI may introduce new biases or perpetuate and institutionalise existing social and procedural biases. For example, models trained on a

population corresponding to the demographics of AI developers may not reflect the broader population and therefore may result in biased outcomes. There is a possibility that the data used to train the AI models could be intentionally or unintentionally skewed towards certain groups or genders. This may depend on the population or patient data used to train the AI.

Connected to bias in the use of AI in accelerating the attainment of SDGs are concerns with misuse of AI. These range from use in surveillance to use in experimentation, ethical dumping and stereotyping in some cases where a lot of data has been collected for what is supposed to be a social good and being used otherwise (Cantemir, 2016; Isaak & Hanna, 2018). Such misuse and manipulation have a long-term negative social impact. It is important also to consider the potential for users with malicious intent, including in areas of experimentation, ethical dumping and drug trial initiative which could be based on the use of data accumulated in developing countries due to weak regulatory infrastructure. Most developing countries have regulatory frameworks that fall short when it comes to the use of AI and the data that is collected to train the algorithms. In such cases, these countries may fall prey to manipulation and misuse of AI on their turf in the name of social good. This is why there is a rise in research efforts to identify best practices and address such issues in academic, non-profit, and private-sector research.

4.3.5 Substitution of Human Labour

Over the years, the health sector has employed people around the globe, including Africa. Despite the argument that AI may enable self-realisation and enable people to flourish in terms of their potential abilities or skills, there is also a potential for substituting people's skills and devaluing human abilities and autonomy. The risk that comes with the use of AI in attaining SDG3, and perhaps most of the SDGs is not the obsolescence of the old skills and the emergence of new ones *per se*, but the pace at which this is happening and the unequal distributions of the costs and benefits that are resulting from it. Of late, we are now noticing a quick disruption of ways of living and a very fast devaluation of old skills at the level of both the individual and society. As pointed out by Floridi et al, (2018) "*at the level of the individual, ways of living are often intimately linked to personal identity, self-esteem, and social role and at the level of society, the deskilling insensitive, skill-intensive domains, such as health care diagnosis may create dangerous vulnerabilities in the event of AI malfunction or an adversarial attack"* (p.690). With such a socio-ethical implication, it is necessary that the society, including all stakeholders of AI and sustainable development, including businesses, seriously think about developing and using AI that extends rather than replaces human intelligence, abilities and autonomy.

4.3.6 Safety

A lot is being said about the use of AI and Big Data in improving health and supporting a healthy existence. However, it is important to ensure that AI and Big Data applications are used safely and responsibly. This is a necessity for their widespread deployment of AI for

social good. Seeking to further social good with AI and Big Data technologies that have adverse consequences would contradict the core mission of SDGs and could also cause a backlash, given the potentially large number of people involved. For AI and Big Data technologies that could affect human life and well-being, it is essential having safety mechanisms in place, including compliance with existing laws and regulations around responsible use of such technologies. For example, if AI misdiagnoses patients in hospitals that do not have a safety mechanism that is put in place, the outcomes could be catastrophic. In the case of developing countries in Africa, the framework for liability and accountability for harm done by AI and Big Data-based technologies is still evolving which poses a great concern when it comes to the use of AI with regards to health in these parts of the world (Manyika & Bughin, n.d.).

Conclusion and Recommendations

The paper has highlighted how AI can be used in the least developed countries in Africa. In particular, the paper addressed the research question on what are the social and ethical implications of implementing AI to accelerate the attainment of SDG3 for least developed African countries were. It discussed the implications of using AI in dealing with global challenges related to health and well-being. Using the OECD ODA list of countries, 32 African countries were selected as focus countries and the PwC SDG selector was used to assess which SDGs would be appropriate to look at for the 32 countries. SDG3, in this case, was chosen because it was a priority goal in 24 of the 32 of the selected countries. Applying a SWOT analysis, the paper was able to analyse the socio-ethical implications of using AI in accelerating SDG3 in the least developed countries. The analysis revealed that despite the strengths and opportunities of using AI in achieving good health and well-being, there are some threats and weaknesses that ought to be considered along with AI implementation. Thus, the paper furthers the argument and current discourse on the need for society and other stakeholders, including businesses to reflect on the social and ethical implications resulting from emerging technologies such as AI in dealing with global issues such as health and well-being that are targeted by the UN SDGs.

The paper has shown that health and well-being remain a factor that impact least developed countries. Having applied a SWOT analysis in order to understand what strengthens, weakness, opportunities and threats exist in applying an emerging technology such as AI, the revelation is that there exist potential issues around data privacy and around the collection and use of personal health data for AI-based decisions. This leaves health data open to data mismanagement as well as data falling into the wrong hands which can lead to data misappropriation.

Another key issue that was revealed from the analysis was the aspect of transparency and accountability. This is a weakness in terms of how AI can be used or misused in making health care and well-being decisions. An additional concern was on the issue of job loss. With the advent of AI in the healthcare system, there is a concern of loss of jobs in the healthcare sector which also leads to the loss of personal relations between health care

practitioners and the public which can subsequently lead to issues of isolation particularly in communities where personal relations are considered very important and a priority. Further, technologies bring about added value in health diagnosis and can be quite expensive in their initial implementation and use. As such, for those that can afford such technologies at the initial stages, these opportunities have the potential to better their health and well-being but for those without the ability to afford them, this can exacerbate the digital and accessibility divide. This can lead to their inability to take advantage of the opportunities that technologies like AI can bring.

Although there are threats and weaknesses as a result of AI, it is also evident that there are strengthens as well as opportunities. These include timely and efficient diagnosis of diseases, as well as the discovery of new drugs through the predictive power of AI. Additionally, by using AI, least developed countries can circumvent issues of infrastructure. For instance, AI could be used for remote diagnosis of diseases, tracking pandemics and use of AI drones to deliver health care resources. With the above, the following recommendations are fitting:

The implementation of stringent regulations around the use of health data to ensure and guard against privacy. There needs to be clear guidelines and enforcement mechanisms of such regulations especially when new technologies become mainstream.

There is also a need for awareness across the countries under focus in areas around issues of consent and processes of using AI in coming up the healthcare interventions. Awareness should be across the board and should involve all stakeholders including industry, policymakers, the public, civil society organisations (CSOs) as well as the health sector. This will allow the understanding and dealing with aspects related to privacy, data protection and proper management of health data more appropriately.

With respect to job losses, policymakers need to put in place mechanisms that allow for retraining and education in emerging technologies such as AI. Skills building that will support the use of AI within the populations and within the health sector in terms of how best they can use AI also needs to be put in place by respective governments. This will allow the countries to best prepare themselves when it comes to access of AI-based resources and ultimately the implementation and use of AI for promoting good health and well-being.
In concluding, the recommendations can go some way to consider the social and ethical implications of implementing AI to accelerate the attainment of SDG3 for least developed African countries particular when different stakeholders are involved including industry, CSOs, the public as well as policymakers.

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Appendices

8.1 Appendix 1: UN Sustainable Development Goals

GOAL 1: No Poverty

GOAL 2: Zero Hunger

GOAL 3: Good Health and Well-being

GOAL 4: Quality Education

GOAL 5: Gender Equality

GOAL 6: Clean Water and Sanitation

GOAL 7: Affordable and Clean Energy

GOAL 8: Decent Work and Economic Growth

GOAL 9: Industry, Innovation and Infrastructure

GOAL 10: Reduced Inequality

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption and Production

GOAL 13: Climate Action

GOAL 14: Life Below Water

GOAL 15: Life on Land

GOAL 16: Peace and Justice Strong Institutions

GOAL 17: Partnerships to achieve the Goal

8.2 Annex 1: OECD DAC List of ODA Recipients

DAC List of ODA Recipients
Effective for reporting on 2020 flows

Least Developed Countries	Other Low Income Countries (per capita GNI <= $1 005 in 2016)	Lower Middle Income Countries and Territories (per capita GNI $1 006-$3 955 in 2016)	Upper Middle Income Countries and Territories (per capita GNI $3 956-$12 235 in 2016)
Afghanistan	Democratic People's Republic of Korea	Armenia	Albania
Angola[1]	Zimbabwe	Bolivia	Algeria
Bangladesh		Cabo Verde	Antigua and Barbuda[2]
Benin		Cameroon	Argentina
Bhutan[1]		Congo	Azerbaijan
Burkina Faso		Côte d'Ivoire	Belarus
Burundi		Egypt	Belize
Cambodia		El Salvador	Bosnia and Herzegovina
Central African Republic		Eswatini	Botswana
Chad		Georgia	Brazil
Comoros		Ghana	China (People's Republic of)
Democratic Republic of the Congo		Guatemala	Colombia
Djibouti		Honduras	Costa Rica
Eritrea		India	Cuba
Ethiopia		Indonesia	Dominica
Gambia		Jordan	Dominican Republic
Guinea		Kenya	Ecuador
Guinea-Bissau		Kosovo	Equatorial Guinea
Haiti		Kyrgyzstan	Fiji
Kiribati		Micronesia	Gabon
Lao People's Democratic Republic		Moldova	Grenada
Lesotho		Mongolia	Guyana
Liberia		Morocco	Iran
Madagascar		Nicaragua	Iraq
Malawi		Nigeria	Jamaica
Mali		Pakistan	Kazakhstan
Mauritania		Papua New Guinea	Lebanon
Mozambique		Philippines	Libya
Myanmar		Sri Lanka	Malaysia
Nepal		Syrian Arab Republic	Maldives
Niger		Tajikistan	Marshall Islands
Rwanda		Tokelau	Mauritius
Sao Tome and Principe[1]		Tunisia	Mexico
Senegal		Ukraine	Montenegro
Sierra Leone		Uzbekistan	Montserrat
Solomon Islands[1]		Viet Nam	Namibia
Somalia		West Bank and Gaza Strip	Nauru
South Sudan			Niue
Sudan			North Macedonia
Tanzania			Palau[2]
Timor-Leste			Panama[2]
Togo			Paraguay
Tuvalu			Peru
Uganda			Saint Helena
Vanuatu[1]			Saint Lucia
Yemen			Saint Vincent and the Grenadines
Zambia			Samoa
			Serbia
			South Africa
			Suriname
			Thailand
			Tonga
			Turkey
			Turkmenistan
			Venezuela
			Wallis and Futuna

(1) General Assembly resolution A/RES/70/253, adopted on 12 February 2016, decided that Angola will graduate on 12 February 2021. General Assembly resolution A/73/L.40/Rev.1, adopted on 13 December 2018, decided that Bhutan will graduate on 13 december 2023 and that Sao Tomé and Principe and Solomon Islands will graduate on 13 December 2024. General Assembly resolution A/RES/68/18, adopted on 4 December 2013, decided that Vanuatu will graduate on 4 December 2017. General Assembly resolution A/RES/70/78, adopted on 9 December 2015, decided to extend the preparatory period before graduation for Vanuatu by three years, until 4 December 2020, due to the unique disruption caused to the economic and social progress of Vanuatu by Cyclone Pam.

(2) According to World Bank data from 10 July 2019, Antigua and Barbuda, Palau and Panama exceeded the high-income threshold in 2017 and 2018. In accordance with the DAC rules for revision of this List, if they remain high income countries until 2019, they will be proposed for graduation from the List in the 2020 review.

Source: *DAC List ODA Recipients 2018 to 2020*.

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: